Agropedology 2018, 28 (01), 70-74

Effect of Different Levels of Nitrogen and Sulphur on Yield and Nutrient Uptake by Fennel (*Foeniculum vulgare* Mill.)

H.C. Kucha, H.L. Sakarvadia, L.C. Vekaria* and K.B. Parmar

Department of Agricultural Chemistry and Soil Science, Junagadh Agricultural University, Junagadh-362001, Gujarat, India

Abstract: An experiment comprising of four levels of nitrogen *viz*., 0, 60, 90 and 120 kg ha^{-1} and three levels of sulphur *viz*., 0, 20 and 40 kg ha^{-1} was conducted in a factorial randomized block design, replicated thrice during *rabi* 2016-17 at the Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh to study the influence of N and S on yield and uptake of nutrients by fennel. The experimental medium deep black soil was clay in texture and had pH 8.06 and EC 0.41 dSm^{-1}. Application of nitrogen @ 120 kg ha^{-1} and 40 kg S ha^{-1}individually had significant effect on yield and uptake of N, P, K, S, Fe, Mn, Zn and Cu by seed and stover. Application of 90 kg N ha^{-1} with 40 kg S ha^{-1} produced significantly higher seed and stover yield than the other treatments.

Keywords : *Fennel, nitrogen, sulphur, yield and nutrients uptake*

Introduction

Fennel (*Foeniculum vulgare),* is an important seed spice, a native of southern Europe and Mediterranean area. It is commonly known as *Saunf* or *Badi-saunf* and in Gujarat it is locally known as Variari. The plant is pleasantly aromatic and is used as a pot herb. The seeds are aromatic, stimulant and carminative.

Nitrogen plays an important role in synthesis of chlorophyll and amino acids that contribute to the building unit of protein and thus growth of plants. An adequate supply of N is associated with vigorous vegetative growth and dark green colour and it plays an important role in the synthesis of the plant constituents through the action of different enzymes (Jones *et al.* 1991).In Fennel, sulphur is the fourth major plant nutrient after nitrogen, phosphorus and potassium and it helps in the synthesis of amino acids, proteins, oils, vitamins, enzymes and chlorophyll. The need for sulphur has also been identified because of the increased use of S-free fertilizers and higher productivity of crops associated with higher uptake of sulphur (Ponkia *et al.* 2018). Keeping in view the role of N and S in the biosynthesis of different organics, influencing the productivity of funnel, the present study was undertaken.

Materials and Methods

A field experiment was conducted on fennel (*var*. Gujarat Fennel-11) at instructional farm, Junagadh Agricultural University, during *rabi* season of 2016-17 in factorial randomized block design with four levels of nitrogen*viz*.,0, 60, 90 and 120 kg ha^{-1} and three levels of sulphur *viz*., 0, 20 and 40 kg ha^{-1} and treatments were replicated thrice.The experimental soil was clay in texture and slightly alkaline (pH 8.06) with EC (0.41dSm^{-1}), medium in available nitrogen (262 kg ha^{-1}), phosphorus (29 kg P_2O_5 ha^{-1}), potassium (218 kg K_2O ha^{-1}), sulphur (10.64 mg kg^{-1}), iron (5.24

*Corresponding author: (Email: lalit@jau.in)

mg kg^{-1}), zinc (0.74 mg kg^{-1}), high in manganese (15.84 mg kg^{-1}) and copper (1.40 mg kg^{-1}).A basal dose of 30 kg P_2O_5 was applied. The crop was harvested at 146 days after sowing.

The representative plant and seed samples from each plot was oven dried at 60 °C for 24 hours and then powdered. The known quantities of powdered samples were digested in a diacid mixture as per method described by Johnson and Ulrich (1969). The acid extract was used for the determination of phosphorus, potassium, sulphur, iron, zinc, manganese and copper. The nitrogen from plant samples were estimated by micro Kjeldahl method as described by A.O.A.C (1975). The phosphorus was determined by Vanadomolybdo phosphoric yellow colour method and potassium by flame photometer as described by Jackson (1974); sulphuras per the method developed by Williams and Steinbergs (1959). Micronutrient cations were estimated by Atomic Absorption Spectrophotometer (AAS) as described by Lindsay and Norvell (1978). Uptake of the nutrients by plant is based on yield and concentration in respective plant parts.

Results and Discussion

Effect of nitrogen

The data (Table 1) revealed that different levels of nitrogen had significant influence on seed and stover yield. Application of 120 kg Nha^{-1}produced significantly higher seed (1826 kg ha^{-1}) and stover (3583 kg ha^{-1})yield and it was remain statistically at par with 90 kg N ha^{-1}. The present findings are in the conformity of those reported by Pratap *et al.* (2003) and Bhardwaj and Kumar (2016).

Application of different levels of nitrogen had significant effect on N, P, K, S, Fe, Mn, and Zn and Cu uptake by seed and stover of fennel. The application of 120 kg nitrogen ha^{-1}resulted in significantly higher uptake of nitrogen, phosphorus, potassium and sulphur to the tune of 50.84, 3.92, 8.52 and 5.82 kg $ha^{-1}$by seed (Table 3) and 34.21, 10.04, 20.4and 35.45 kg $ha^{-1}$by stover (Table 4), respectively. Significantly higher uptakes of Fe, Mn, Zn and Cu uptake 250, 40.22, 76.84 and 43.30g $ha^{-1}$by seed (Table 5) and 255, 131, 60.31 and 47.17 g $ha^{-1}$by stover (Table 6) were also observed with application of 120 kg nitrogen ha^{-1}, respectively. This might be attributed to higher availability of nutrients in root zone and enhanced metabolic activity at the cellular level. The results of present investigation are in agreements with the findings of Patel *et al*. (2000) and Mehta *et al.* (2011).

Effect of sulphur

Application of sulphur significantly influenced the seed and stover yield of fennel (Table 1). Significantly higher seed (1949 kg ha^{-1}) and stover (3751 kg ha^{-1}) yield were found with application of 40 kg S ha^{-1}.The increase in seed yield with increasing levels of sulphur might be due to increased photosynthesis *via* better development and thickening of xylem and collenchymas tissues. Pratap *et al.* (2003) also reported similar findings in fennel.

Application of sulphur significantly affected the uptake of macro (Table 3) and micronutrients (Table 4) by seed and stover of fennel. Application of 40 kg S ha^{-1}recorded significantly higher uptake of nitrogen, phosphorus, potassium and sulphur to the magnitude of 47.19,4.14, 8.93 and 6.59 kg ha^{-1} by seed (Table 3) and 31.21, 10.60, 21.4 and 40.78 kg ha^{-1} by stover (Table 4), respectively. Similarly, significantly higher uptakes of Fe, Mn, Zn and Cu *i.e.*277, 40.44, 81.70 and 46.57g $ha^{-1}$by seed (Table 5) and 263, 134, 63.02 and 47.44 g $ha^{-1}$by stover (Table 6) were also observed with the application of 40 kg S ha^{-1} owing to its influence on growth and yield attributes of crop. These findings are in agreement with those reported by Pratap *et al.* (2003).

Interaction effect

The interaction between nitrogen and sulphur application on seed and stover yield was found significant (Table 2). Application of 90 kg N ha^{-1} along with 40 kg S ha^{-1} recorded significantly higher seed (2158 kg ha^{-1}) and stover(4194kg ha^{-1}) yield than other treatments. However, it was statistically comparable with treatment $N_{60}S_{40}$ and $N_{120}S_{40}$. The present findings are in close agreement with the results obtained by Pratap *et al.* (2003).

Table 1. Effect of different levels of nitrogen and sulphur on yield of fennel

Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
Nitrogen levels (kg N ha^{-1})		
N_0(Control)	1400	2738
N_{60}	1666	3288
N_{90}	1774	3481
N_{120}	1826	3583
S.Em ±	45	84
C.D. at 5%	131	248
Sulphur levels (kg S ha^{-1})		
S_0 (Control)	1443	2898
S_{20}	1607	3169
S_{40}	1949	3751
S.Em±	39	73
C.D. at 5%	114	214
Interaction (N x S)		
S.Em.±	77	146
C.D. at 5%	227	429
C.V.%	8.10	7.70

Table 2. Interaction effect of nitrogen and sulphur on seed and stover yield of fennel

Levels of Nitrogen	Levels of sulphur							
	Seed yield (kg ha^{-1})				Stover yield (kg ha^{-1})			
	S_0	S_{20}	S_{40}	Mean	S_0	S_{20}	S_{40}	Mean
N_0	1332	1382	1487	1400	2614	2808	2794	2738
N_{60}	1362	1619	2017	1666	2792	3148	3925	3288
N_{90}	1488	1675	2158	1774	2975	3276	4194	3481
N_{120}	1591	1754	2132	1826	3211	3444	4093	3583
Mean	1443	1607	1949		2898	3169	3751	
S.Em±		77				146		
C.D. at 5%		227				429		

Table 3. Effect of different levels of nitrogen and sulphur on N, P, K and S uptake by seed of fennel

Treatments	Uptake by seed (kg ha^{-1})			
	N	P	K	S
Nitrogen levels (kg N ha)				
N_0 (Control)	25.79	2.92	6.24	4.40
N_{60}	37.89	3.65	7.63	5.31
N_{90}	45.74	3.78	8.37	5.70
N_{120}	50.84	3.92	8.52	5.82
S.Em ±	1.86	0.15	0.28	0.23
C.D. at 5%	5.45	0.44	0.81	0.69
Sulphur levels (kg S ha^{-1})				
S_0 - (Control)	33.93	3.06	6.76	4.11
S_{20}	39.07	3.51	7.37	5.22
S_{40}	47.19	4.14	8.93	6.59
S.Em ±	1.61	0.13	0.24	0.20
C.D. at 5%	4.72	0.380	0.701	0.60
Interaction (N x S)				
S.Em.±	3.22	0.26	0.48	0.41
C.D. at 5%	NS	NS	NS	NS
C.V.%	13.91	12.58	10.77	13.23

Table 4. Effect of different levels of nitrogen and sulphur on uptake of N, P, K and S by stover

Treatments	Uptake by stover (kg ha^{-1})			
	N	P	K	S
Nitrogen levels (kg N ha^{-1})				
N_0(Control)	17.87	7.63	15.6	27.43
N_{60}	24.98	9.27	18.6	33.00
N_{90}	31.10	10.00	19.9	35.16
N_{120}	34.21	10.04	20.4	35.45
S.Em±	1.01	0.43	0.90	1.44
C.D. at 5%	2.96	1.27	2.64	4.23
Sulphur levels (kg S ha^{-1})				
S_0(Control)	23.81	8.20	16.5	24.87
S_{20}	26.09	8.90	18.0	32.62
S_{40}	31.21	10.60	21.4	40.78
S.Em±	0.87	0.38	0.78	1.25
C.D. at 5%	2.56	1.10	2.29	3.66
Interaction (N x S)				
S.Em.±	1.75	0.75	1.56	2.50
C.D. at 5%	NS	NS	NS	NS
C.V.%	11.19	14.11	14.50	13.21

Table 5. Effect of different levels of nitrogen and sulphur on uptake of Fe, Mn, Zn and Cuby seed

Treatments	Uptake by seed (g ha^{-1})			
	Fe	Mn	Zn	Cu
Nitrogen levels (kg N ha^{-1})				
N_0(Control)	194	28.78	56.99	29.46
N_{60}	237	33.91	69.17	37.73
N_{90}	252	36.87	73.87	42.34
N_{120}	250	40.22	76.84	43.30
S.Em ±	8	1.30	2.19	1.87
C.D. at 5%	24	3.82	6.44	5.47
Sulphur levels (kg S ha^{-1})				
S_0 (Control)	199	30.54	58.97	31.81
S_{20}	223	33.86	66.98	37.24
S_{40}	277	40.44	81.70	46.57
S.Em ±	7	1.13	1.90	1.62
C.D. at 5%	21	3.31	5.37	4.74
Interaction (N x S)				
S.Em. ±	14	2.26	3.80	3.23
C.D. at 5%	NS	NS	NS	NS
C.V.%	10.72	11.19	9.51	14.65

Table 6. Effect of different levels of nitrogen and sulphur on uptake of Fe, Mn, Zn and Cu) by stover of fennel

Treatments	Uptake by stover (g ha^{-1})			
	Fe	Mn	Zn	Cu
Nitrogen levels (kg N ha^{-1})				
N_0 (Control)	189	102	45.18	36.05
N_{60}	228	118	54.49	42.59
N_{90}	239	122	58.30	44.36
N_{120}	255	131	60.31	47.17
S.Em ±	9	6	2.11	1.59
C.D. at 5%	25	16	6.19	4.67
Sulphur levels (kg S ha^{-1})				
S_0 (Control)	200	103	48.47	37.57
S_{20}	220	117	52.23	42.62
S_{40}	263	134	63.02	47.44
S.Em ±	7	5	1.83	1.38
C.D. at 5%	22	14	5.36	4.04
Interaction (N x S)				
S.Em.±	15	10	3.65	2.76
C.D. at 5%	NS	NS	NS	NS
C.V.%	11.31	14.09	11.60	11.23

References

A.O.A.C. (1975).Official Methods of Analysis (12th Edition) William Strawetgled. Published by A.O.A.C., Washington, DC, pp.506-508.

Bhardwaj, R.L., and Kumar, D. (2016). Effect of varying levels of nitrogen on growth, yield, quality and profitability of transplanted fennel (*Foeniculum vulgare* Mill.). *Journal of Spices and Aromatic Crops* **25**, 141–148.

Jackson, M.L. (1974). *Soil Chemical Analysis*.*Prentice* Hall of India Pvt. Ltd., New Delhi, pp. 327-350.

Johnson, C.M., and Ulrich, A. (1969)."Analytical Method for Use in Plant Analysis".Bulletin, California Agric. Expt. Stn., 766.

Jones, I.B.,Wolf, B., and Milles, H.A. (1991). *Methods of Elemental Analysis* (Chapter- 4)*In*: Plant Analysis Handbook**.** Macro-Micro Publishing, Athens, Georgia. pp 27-38.

Lindsay, W.L., and Norvell, W.A.(1978).Development of a DTPA test for Zinc, Iron, Manganese and Copper. *Soil Science Society of America Journal* **42**, 421-428.

Mehta, R.S., Anwer, M.M., and Aishwath, O.P. (2011). Growth and yield of fennel (*Foeniculum vulgare* Mill.) as influenced by irrigation, nutrient levels and crop geometry. *Journal of Spices and Aromatic Crops* **20**, 77-80.

Patel, B.S., Patel, K.P., Pate, I.D., and Patel, M.I. (2000).Response of fennel (*Foeniculum vulgare*) to irrigation, nitrogen and phosphorus. *Indian Journal of Agronomy* **45**, 429-432.

Ponkia H.P., Vekaria, L.C., Ramani, V.B., Sakrvadia, H.L., Polara K.B., and Babaria, N.B. (2018).Potassium and sulphur fertilization of wheat (*Triticuma estivum* L.) in medium black calcareous soils of Saurashtra Region of Gujarat. *International Journal of Chemical Studies* **6,**1634-1640.

Pratap, R., Meena, N.L. and Yadav, G.L. (2003).Effect of nitrogen and sulphur on growth and yield of fennel. *Annals of Arid Zone* **42**, 97-99.

Williams, C.H., and Steinbergs, A. (1959).Soil sulphur (Heat soluble sulphur or available sulphur) fractions as chemical indices of available sulphur in some Australian soils. *Australian Journal of Agricultural Research* **10**, 340-352.

Received: February, 2018 Accepted: June, 2018